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EQUIPMENT FOR PRODUCTION AND HARVESTING OF SWEETPOTATOES

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(Presented at the Meeting of American Society of
Agricultural Engineers at Knoxville, Tenn., June 25, 1941)

Chemical research and applied engineering have found methods of making important commercial products from the sweetpotato. At this time, the extensive industrial utilization of this crop is being delayed by two major factors: (1) the rapid rate of deterioration of the harvested crop and (2) the relatively high cost of raw material in comparison with the prices that can be obtained for the products.

The Federal Government, realizing the many problems connected with the establishment of an industrial outlet for sweetpotatoes, has given different forms of material assistance. Paine, Thurber and others (1)* of the Agricultural Chemical Research Division of the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, have developed suitable processes for making white sweetpotato starch. At Laurel, Mississippi, the Farm Security Administration has sponsored a farm cooperative as the manufacturer. Through the payment of a subsidy, the Agricultural Adjustment Administration has encouraged neighboring farmers to grow sweetpotatoes for starch production.

The commercial acceptance, the increasing demand and the premium prices received for the sweetpotato starch made by the Laurel Starch Plant have justified the Department's expectations as to the quality of the product and its possible substitution for imported root starches.

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* For references see "Literature Cited" at end of article.

The results on the farm side of the new project are not so bright and they are somewhat confusing. Ware(2) and others have proved that the sweetpotato crop has a high potential industrial value due to its adaptability to southern field conditions, its dependability and its high yield capacity. In actual practice the average production of sweetpotatoes is low because the farmer generally grows the crop for his own needs. The average yield was approximately 75 bushels per acre in the Laurel area before the erection of the Laurel Starch Plant. In recent years there has been a remarkable improvement in production per acre. Many farmers now average 250 bushels per acre. Still the average acreage per farm is low; hence 1075 members of the cooperative in 1939 and 992 members in 1940 failed to produce 350,000 bushels, the seasonal capacity of the Laurel factory.

Recent analyses indicate that a sweetpotato starch factory should have a seasonal capacity of 750,000 to 1,000,000 bushels to lower the unit cost of manufacture and make the finished product's value exceed all items of cost. When the Laurel plant was set up, it was estimated that a price of 20 cents per bushel could be paid for sweetpotatoes on the basis of a 100-day operating season. Conditions have not materially changed from that time with regard to price based upon normal starch content and values. Under war conditions or the availability of new varieties of sweetpotatoes with a higher percentage of starch, the price paid to farmers can be more. The 1941 starch plant price will be 15 cents paid by the factory, plus 12½ cents subsidy from A.A.A., and possibly plus 2 cents bonus to be paid by the factory if the total production of the cooperatives exceeds 325,000 bushels.

Guin and others (3) of the Mississippi Agricultural Experiment Station found by a 1939 survey of selected farmers that the average cost of production of sweetpotatoes was 25 cents per bushel. This cost was based upon an average of 5.7 acres in sweetpotatoes on the farms surveyed, with an average yield of 166 bushels per acre.

There is increasing interest in the possibilities of dehydrated sweetpotatoes in the form of meal or cossettes, due to local shortages of carbohydrate feeds and the superior value of the meal as shown by feeding tests conducted by several southern agricultural experiment stations. Normal starch prices, prices for livestock in competitive markets and crop processing costs indicate that sweetpotatoes must be grown and delivered for 10 to 15 cents per bushel if there is to be a profit in each part of a balanced sweetpotato-growing and stock-raising farm program. These figures are a challenge to the ingenuity of the agricultural engineer, the farm-machinery manufacturer and the farmer.

Significant improvements have been made by 61 cooperators in their farm management and in the production of sweetpotatoes. These few growers differ from the mass of 1 to 3-acre producers by having not less than 10 acres of sweetpotatoes with high average yields. The results of such larger-scale production combined with the use of specially developed equipment, indicate that the growers will eventually produce the crop at a price which will insure a profit to both the producer and the processor. It takes time to gain experience and develop suitable equipment for large-scale production of sweetpotatoes, which heretofore have been grown by cultural methods designed to limit the yield in order to have uniform-shaped, small potatoes. My intention is to summarize here some of the changes, adaptations and new ideas connected with the production of starch-making sweetpotatoes:

Seedbed Preparation

Seedbed preparation for sweetpotatoes has given the cotton farmer no special problem. For the most part, the methods and equipment commonly used for cotton have been found suitable. However, in practice the small power units available have limited such work to shallow tillage, which, with other factors, has developed a definite "plow-sole" and kept down the yields of the root crop. Preliminary results indicate marked advantages for the general-purpose tractor equipped with standard cotton-tillage implements. The major difference to be considered in the us of the tractor cotton-tillage equipment to prepare soil for sweetpotatoes instead of cotton is that sweetpotatoes need a high bed during the entire growing season, whereas cotton beds are comparatively low.

Transplanting

The transplanting season is the most difficult period for a cotton farmer who attempts to grow a large acreage of sweetpotatoes. The new crop diversification programs have piled up a whole series of "must" jobs which should be done about the same time. Plowing under winter legumes, harvesting oats, chopping cotton, sowing summer hay crops, all combined with the usual cultivations, leave little time for sweetpotato transplanting.

Most growers use a minimum-size hotbed for the propagation of their sweetpotato plants. Hence, a limited supply of plants at any one time tends to prolong the transplanting work from six to ten weeks. The limited planting material may also prevent planting in the field during favorable moisture conditions.

Horticulturists and heating engineers are working together on the problems of sweetpotato plant production. The Bureau of Plant

Industry, U. S. Department of Agriculture, and cooperating southeastern agricultural experiment stations have new varieties of sweetpotatoes which may prove superior to the Triumph, now commonly grown, in plant production and in characteristics needed for industrial utilization. Anderson (4 and 5) of the Mississippi Agricultural Experiment Station has developed improved methods of sweetpotato-plant production.

Through the use of existing information and suitable home-made equipment, a few Laurel growers have demonstrated that it is possible to reduce the plant cost per acre to about $3.00 in contrast to $17.50 when plants from commercial sources are used in typical close spacing in the row.

The common hand method of transplanting is to drop the plants on the bedded and fertilized row, push the roots into the soil with a notched stick and then compact the soil with the foot. Sweetpotatoes grown for the commercial market are closely spaced, from 6 to 12 inches apart, in the row to force the production of many small roots. There is no maximum-size limit for industrial and feed outlets. Therefore as an economy in seed stock the plant spacings now range from 16 to 30 inches in the Laurel area. The labor requirements for hand transplanting vary from 20 to 30 man-hours per acre. These figures may be doubled if water is applied to the transplants.

Only a few of the one-row, horse-drawn mechanical transplanters sold to the Laurel growers have been used in planting a major part of the owner's crop. The general criticisms of these machines are that the usual farm labor cannot do accurate work and that a small mule cannot pull the machine at a uniform speed. Hillsides and terraces make unfavorable conditions for the operation of this machine which is designed for level fields.

Three types of experimental transplanters were used in 1941. These were: (1) a direct tractor-mounted one-row unit which was especially satisfactory on small and terraced fields (the location of the plant-setter in front of the driver permits full control of the planting operation); (2) a two-row experimental unit with a capacity of 3/4 to 1 acre per hour, which is pulled by a tractor and combines the operations of bedding, fertilizer application and transplanting; and (3) a one-row horse-drawn machine having equipment similar to that of the second one mentioned.

Getting and handling water for transplanting still remains an important item of cost. The small operator usually cannot afford a special water tank and pump on a wagon or truck. The large operator must give serious attention to having water convenient and use it in abundance to reduce the cost of replanting.

The care used in preparing and keeping planting material for use on a transplanter influences not only accuracy in transplanting but also the early rate of growth. The plants should be separated, culled and trimmed at the bed and then packed so as to prevent wilting and tangling before their transfer to the machine.

Cultivation

Apparently the objectives of sweetpotato cultivation are simply to keep down weeds and to continue to build up the ridge. The first cultivation is generally deep and close to the plants so as to cover the weeds in the row. Cultivations which follow are rather shallow. Sweeps, shaped to fit the ridge, are used to work the soil from the middle into the bed. Some farmers use the middlebuster to "lay by" the crop. The one-mule, two-row rotary hoe has been used with some advantage in the reduction of manual cultivation.

Harvesting

The direct industrial utilization of the sweetpotato brings up a series of harvesting problems new to a cotton farmer. From the standpoint of the factory there must be an orderly supply of fresh raw material. The typical grower has many reasons why he cannot take his "turn-at-the-mill" to make a long efficient processing season. The date of maturity of sweetpotatoes does not materially complicate the program. Early-planted sweetpotatoes have made satisfactory yields by the middle of August. Hoffman (6) of the Bureau of Plant Industry has found that the normal period of factory operation can be extended by means of field storage or delayed digging. The crop processing season may be 100 to 130 days at Laurel.

The direct industrial utilization of the sweetpotato gives the farmer a great latitude with regard to the physical condition of the delivered crop. Dirt, "strings" or enlarged roots, and rot are the only restrictions. Rough handling, which gives an opportunity for the development of high capacity digging and transportation operations, is permissible.

The growers in the Laurel area have made many improvements resulting in lower harvesting costs. The old practice of hoeing or pulling the vines off the rows to aid digging is seldom used. Splitting the row once with the 12- or 14-inch middlebuster equipped with a rolling coulter has replaced the former practice of running on each row four to six plow furrows for an equal number of hand gathering operations.

The middlebuster combination only partially exposes the sweetpotatoes. Often the land is harrowed or replowed to finish gathering the crop. The general efficiency of the middlebusters can be improved by the use of rod wings developed by Jones and Anderson of the Mississippi Agricultural Experiment Station. In one case the one-row tractor equipment has been modified by using disc hillers on the front part of the cultivator to get the vine growth out of the way and by using 22-inch point and rod wings on the middlebuster frame to separate the sweetpotatoes from the soil.

The conventional, rod-type, mechanical white-potato digger is not adapted for digging sweetpotatoes when the vines are green and rank. Fair results have been obtained with this mechanical digger when the vines were previously hoed from the row. The equivalent of these operations has been obtained by pulling the digger with a tractor equipped with an A-frame vine cutter. This vine cutter is a special disc-hiller attachment on a standard cultivator frame. It was most effective when fitted with four or six hillers and so mounted that the vines and surface dirt over the sweetpotatoes were plowed into the middles.

Two experimental mechanical diggers have been developed by the Bureau of Agricultural Chemistry and Engineering. One is a direct-mounted tractor unit which was extensively used during the past two seasons with excellent results. In 1939, in one field previously harvested with mule equipment, this unit gathered an additional 30 to 35 bushels per acre, which was equivalent to 15 to 22 percent increased yield. The other machine used only in 1940, was a combination digger and truck loader. This new digger will require further development and testing to determine its merit.

Collecting Sweetpotatoes

More than 90 percent of the sweetpotatoes purchased by the Laurel plant are delivered in bags. In the earlier years of this factory's operation the bags were carefully filled by individual packing similar to that used in filling crates with table stock. It is now common practice to throw the potatoes into "heap-rows" made up from potatoes collected from three to five adjacent rows. The gatherers then drag bags along this row and collect the potatoes.

The bagging-sled has now become a common piece of farm equipment in the Laurel area. It carries 2 to 4 open bags and is hauled along the dug rows by a team of mules so the gatherers can throw the potatoes directly into the bag in place of the usual "heap-row". This direct bagging has greatly reduced the time and labor required. Interlocking by proper arrangement of filled bags on the truck or wagon has eliminated an old practice of fastening the open end of the bag.

An experimental rubber-tired cart has been found preferable to the sled because a greater number of bags can be handled and pulled to the "turn-row" with the same mule power. The assembly of the crop at the edge of the field, made possible by the cart, tends to lower the transportation charges from the farm to the mill.

A further reduction in gathering costs has been made by collecting the sweetpotatoes directly from the row in wire baskets. After the baskets are filled they are carried directly to the bagging cart or sled and emptied into the bags. A field foreman can obtain greater labor efficiency from a large group of workers by using the number of baskets gathered as the basis of wages and by applying penalties for potatoes left on the ground by the workers.

Transportation

The farm wagon and the small auto truck were the common vehicles used for transportation of sweetpotatoes in the first years of the Laurel plant. In 1940 the greater part of the crop was hauled on large commercial trucks. This shifting of the hauling operations to a few units has helped to control the rate of delivery, essential for efficient operation of the factory. This coming season a part of the crop from farms 40 to 200 miles from Laurel will be shipped in box or cattle cars. The railroad shipments will not only help to regulate the harvest but give distant cooperators equal advantages with local growers.

The loose sweetpotatoes in railroad cars and in the factory bins, filled from farmers' trucks, are shoveled into a flume leading to the washer. Washing is the first factory process. The many possible adaptations of the flume and washer system will permit further developments in the equipment and methods used in harvesting and hauling to the factory.

Possible Changes

Large-scale programs of sweetpotato production will require the organization of special crews of men and special equipment for the production of plants, transplanting operations and the collecting and storage of seed stock. Other production operations can be conducted with more or less standard equipment and regular farm labor.

Farmers will take advantage of the latitude allowed by the processing plant with regard to the condition of delivered sweetpotatoes through cooperative use, in rotation, of a limited supply of equipment to save costs. Small cooperators would naturally use low-cost units, while on large-scale operations there would be need for special equipment such as a combine digger and truck loader and other units.

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